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Geology and Water Resources of the Southern Half of the Black Hills and Adjoining Regions in South Dakota and Wyoming. By N. H. Darton. From the Twenty-first Annual Report of U. S. Geological Survey, Part IV.

In his report on the geology of the southern half of the Black Hills, Mr. Darton has given us not only a revision and elaboration of the facts previously known about that interesting region, but has added many which are new and important. The formations which he recognizes in the area are included in the following section:

Pleistocene	River gravels and alluvium.	
Tertiary	Oligocene—White River beds (unconformity).	
Upper Cretaceous	Laramie.	
	Fox Hills.	
	Pierre shales.	
	Niobrara chalk.	
	Benton	Carlysle.
		Inoceramus limestone.
		Graneros shale.
	Dakota sandstone.	
Lower Cretaceous	Fuson.	
	Minnewaste limestone.	
	Lakota sandstone (unconformity).	
Jurassic	Beulah shales.	
	Unkpapa sandstone.	
	Sundance (unconformity).	
Triassic (?)	Spearfish Red Beds.	
Permian	Minnekahta limestone.	
	Opeche.	
Upper Carboniferous	Minnelusa.	
Lower Carboniferous	Pahasapa limestone.	
	Englewood limestone (unconformity).	
Cambrian	Deadwood sandstone and conglomerate.	
Algonkian	Crystalline schists and granites.	

Many of these names are new, and the significance of a few of the older ones has been altered, owing to the better information which the author has gathered regarding fossils and uncomformities.

Although the report deals not only with the geologic history of the Black Hills, but with structure, hydrography, and resources of the region as well, a résumé of the first topic only is here given.

Too little is known of the pre-Cambrian condition of the Black Hills to permit a discussion of it at present. The rocks of that age are a complex system of granites and schists which will require careful study for interpretation. The area was land during early and middle Cambrian times, but toward the close of the period the sea advanced, covering most and perhaps all of the area. The Potsdam or Deadwood sediments were largely derived from the Algonkian Crystalline rocks, as evidenced by the local material contained in the basal Cambrian conglomerate. The Ordovician beds known in the northern Black Hills are not found southward, and both Silurian and Devonian are likewise absent. As to whether the region was land during those three periods or was alternately elevated and submerged, the erosion during the times of elevation being sufficient to remove all the sediments deposited during the periods of submergence, can only be conjectured. The unconformity between the Cambrian and the Carboniferous is inconspicuous.

From the early Carboniferous on through the Trias, sedimentation seems to have been continuous. During the Lower Carboniferous the region was the scene of limestone deposition in an open interior sea. Probably there was no considerable land mass in the vicinity until the Upper Carboniferous. At this time islands are believed to have existed in the neighborhood of the Laramie Mountains of Wyoming, and they probably furnished the clastic material of the Minnelusa formation. Late in the Carboniferous or early in the Permian (the lack of fossils in the Opeche beds prevents a definite location of the horizon) the waters of the area appear to have been inclosed seas, and to have suffered temporary reduction by evaporation in an arid climate. Red clays, interstratified with thin seams of gypsum, indicate such conditions. Mr. Darton was so fortunate as to find a few Permian fossils in the comparatively barren Minnekahta limestone, thereby showing with reasonable certainty that the Permian sea extended farther north and east than was previously supposed. The Spearfish Red Beds are classed as Triassic because of their stratigraphic relation to the Permian and to the Jurassic, and because of their lithologic resemblance to Triassic formations elsewhere in the Western United States. They are almost devoid of fossils. During this period, as in the early Permian, we may suppose that the region about the Black Hills possessed an arid climate and was covered by saline lakes, in which gypsum and red clays were deposited.

The unconformity between the Red Beds and the marine Jurassic doubtless represents an epoch of erosion during the early part of the Jurassic. The Sundance, Unkpapa and Beulah formations belong rather to the later part of the period, and doubtless owe their origin to the great gulf which entered the United States from the northwest at that time. Another period of emergence without distortion of the strata followed the exclusion of this gulf, and no surely marine formations were deposited in the region until after the Dakota epoch of the Cretaceous.

The Lakota, Minnewaste, and Fuson formations were formerly not separated from the Dakota group, but they are now segregated on the testimony of the plant remains contained in the Lakota sandstone. The local unconformities and beds of coal in the Lakota indicate a condition of slight crustal oscillations near sea level. Marine fossils have not been detected in any of the Lower Cretaceous formations nor in the Dakota. The land was probably low, and frequently inundated by lakes, or brought to a marshy condition.

By the beginning of the Benton stage the great interior sea of the Cretaceous had spread over the plains, and in it sediments continued to be deposited until near the close of the period. The prevalence of fine clastic sediments was interrupted by temporary depositions of chalk and limestone in clear open waters. The retreat of the interior sea beginning in the Fox Hills stage was probably completed during the Laramie, a large part of the latter formation being non-marine. Although the Laramie beds do not occur in the Black Hills, they are now upturned like the older beds upon the west side of the uplift, and it is probable that they originally covered the whole of it.

The Black Hills dome was probably uplifted very early in the Eocene. During that epoch it was truncated and fashioned into its present general form. That many of the larger valleys date from that time is proved by the existence of Oligocene deposits even in their deeper portions.

In the Oligocene epoch a great lake is supposed to have partially surrounded the Black Hills and spread far up on their sides, leaving the Dakota hog-back ridges isolated as off-shore islands. In support of the view that the beds are lacustrine the author cites the horizontal continuity of the beds, the fine assortment of the material, and the existence of thin beds of limestone. Although much of the formation has been removed by subsequent erosion, its former extent is roughly indicated by outlines and by a superposition of drainage which allowed many Eocene valleys to drain northward through Neocene cañons cut across the old divides. After the Oligocene no extensive sediments were deposited in the Black Hills. A further uplift of several hundred feet produced a tilting toward the northeast which gave the advantage of gradient to the streams on that side of the uplift and induced frequent captures of the headwaters of the more southerly creeks.

No traces of glaciation have as yet been found in the hills.

E. B.

SUPPLEMENTARY NOTE TO CHARLES S. PROSSER'S PAPER ON "SUNBURY SHALE OF OHIO."

A layer of concretionary sandstone mentioned in the sections on Rocky Fork, Franklin county, showing the lower portion of the Berea grit and the upper part of the Bedford shale, according to latest observations probably belongs in the upper part of the Bedford shale. In this case the concretionary layer, No. 2, of the section of the cliff below the tree on the farm of John Augen is not to be regarded as the base of the Berea sandstone, but in the Bedford shale, while the Berea begins with No. 5.

C. S. P.